DEVELOPMENT OF A COASTAL OCEAN LAGRANGIAN (COOL) FLOAT

Dave Hebert
Graduate School of Oceanography
University of Rhode Island
Narragansett, RI 02882-1197
Tel: (401) 874-6610 Fax: (401) 874-6728 email: hebert@gso.uri.edu

Tom Rossby
Graduate School of Oceanography, University of Rhode Island
Tel: (401) 874-6521 Fax: (401) 874-6728 quad email: tom@rafos.gso.uri.edu

Mark Prater
Graduate School of Oceanography, University of Rhode Island
Tel: (401) 874-6512 Fax: (401) 874-6728 email: mark@seip.gso.uri.edu

Award #: N0000149610356

LONG-TERM GOALS

To understand the structure and dynamics of the cross-shelf/vertical circulation under different forcing conditions such as Ekman upwelling-favourable winds. To determine how small-scale mixing processes affect this circulation.

OBJECTIVES

A new float, the COastal Ocean Lagrangian (COOL) float, based on established RAFOS float technology at the University of Rhode Island, is being designed and constructed in this project. This COOL float will be designed to follow a water parcel in all three directions. The final float will actively change its density in order to follow the water parcel if it changes its density either through mixing or solar heating.

APPROACH

The design of a standard f/h float (Rossby et al. 1994), which is an isopycnal RAFOS float (Rossby et al. 1986) capable of changing its volume (and density) to several pre-determined values, was modified to produce the COOL float (Figure 1).

The first modification to the f/h float was the addition of a low-power compass and vanes (Figure 1). As water flows vertically past the float, the float will rotate and be measured by the compass. The second modification to the float will be the control circuitry of the volume changer (vocha) part of the float. The float will change its volume until as much water flows past the float in the opposite direction. After this volume adjustment has been made, the float should be located in the same water parcel as it was initially placed even though the density of the water may have changed. The present design consists of sixteen predetermined volumes which are used at pre-programmed intervals. After the initial testing of the float, the vocha will modified to supply an almost infinite number of volumes with a small modification to the vocha system.

Figure 1.
Upper left panel: Two possible orientations of the vanes on the COOL float.
Upper right panel: The compressee (cylinder with piston) and 12 kHz pinger at bottom of the float.
Lower left panel: Deployment of a quasi-isobaric (no compressee) COOL float.
Lower right panel: Deployment of the isopycnal COOL float. The compressee is attached below the pinger and used as the drop weight.

WORK COMPLETED

Several engineering tests have been completed. Last year different vane designs were tested with a prototype float (Rajamony et al. 1996). This year the COOL float was deployed in the open ocean in a region where there should be a small diapycnal velocity but vertical velocities due to internal waves. Although a standard isopycnal RAFOS float appears to follow the vertical displacement of an isopycnal by internal waves, it is not clear whether the vanes will affect the float's motion. Also, if there is some slippage and the float rotates, the float will believe that there is a vertical (diapycnal) velocity and thus change its density to follow the water parcel. It is necessary to determine how the float responds in the real ocean in order to determine the true diapycnal velocity and how often the float should change its density. We want to make sure that this density-adjustment process is a not a positive feedback one.

Eight deployments of the COOL float, using a variety of vane angles and with or without a compressee, have been made with total deployment periods ranging from 6 to 13 hours (Hebert et al. 1997). Six of these deployments were off the continental shelf south of Rhode Island and the other two deployments were made off of Oregon during an engineering cruise of Dr. Moum of Oregon State University. The float records temperature and pressure every 64 s and compass heading every 8 s during a 12 hr mission (every 4 s during a 6 hr mission). This data is recorded internally and downloaded after recovery of the float.

RESULTS

In each deployment, the float descends to the predetermined density surface. As it sinks, the float rotates rapidly as water flows past it (Figure 2). Then, the float remains on a density surface while being advected by the horizontal currents. This portion of the deployment will be referred to as the mission. The float is tracked acoustically from the ship. If there is a vertical flow past the float, the float will rotate. To determine this vertical velocity, it is necessary to relate the speed of the float's rotation to a vertical velocity. Thus, at the end of the float mission, the float makes 5 VOCHA moves which changes the float's density and makes it move vertically. The pressure and compass data allows us to determine the rotation rate – velocity calibration for the float.

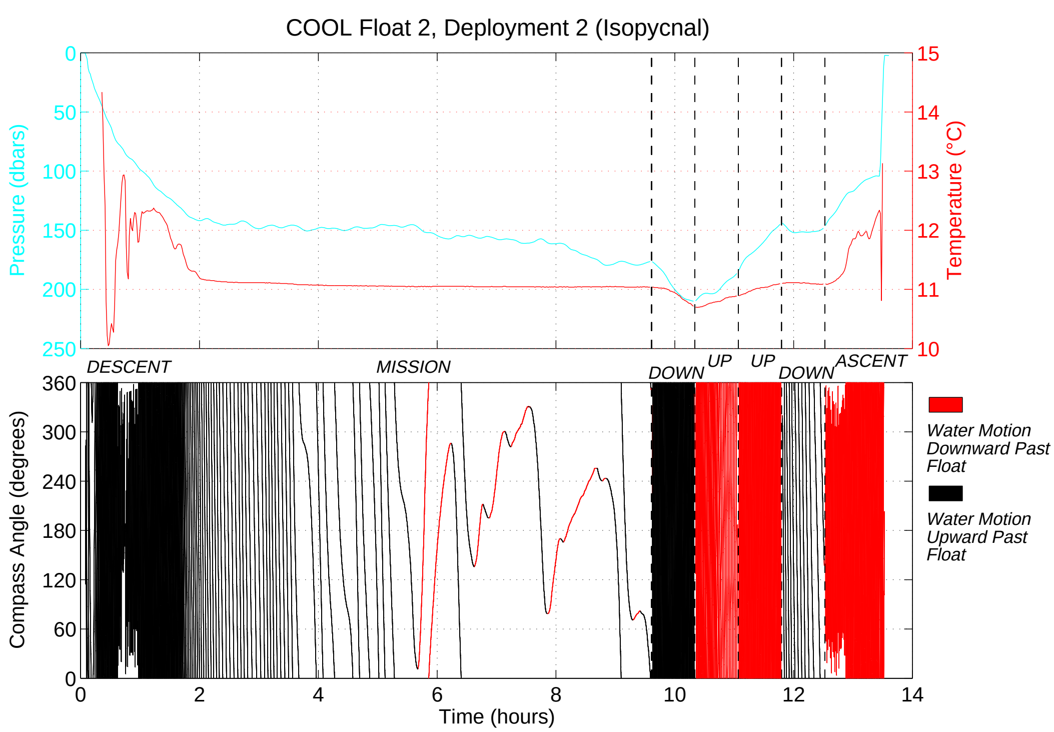

Figure 2.
Pressure, temperature (top panel) and compass heading (bottom panel) recorded by the COOL float for a deployment.

Near the end of the deployment, the float burns a release wire, drops a weight and returns to the surface for recovery. A flasher, located at the top of the float, is activated for easy spotting at night. The float is recovered simply using a boat hook and attaching lines to the bail (Figure 1).

For this example of a COOL float deployment (Figure 2), it is evident that the float was on a density surface whose properties and dynamics were changing during its mission (Figure 3). CTD casts taken near the float show significant variability of temperature and salinity in this region. Post-cruise analysis of satellite images indicate that the float was deployed near the edge of a warm-core ring.

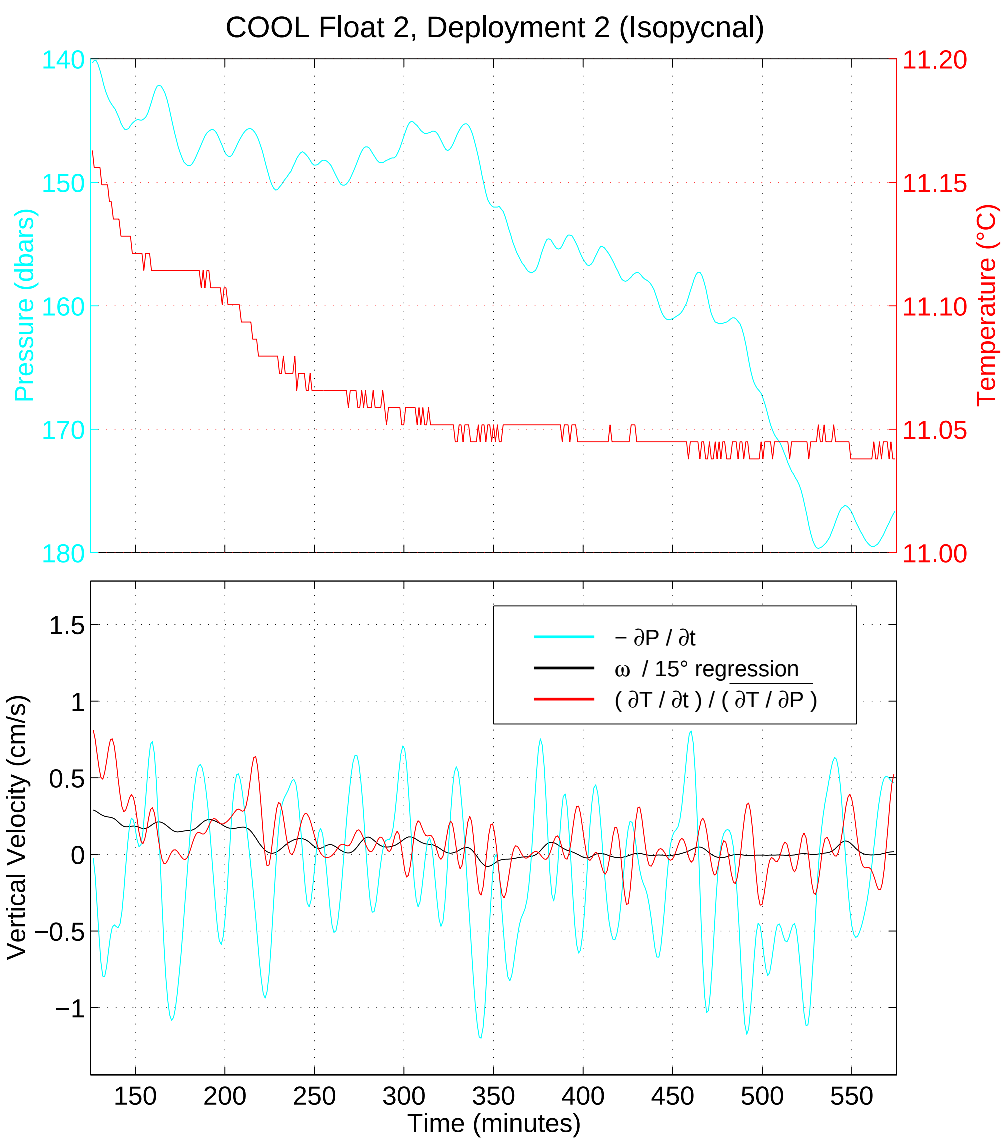

Figure 3
Top panel: Temperature and pressure recorded by the COOL float while on an isopycnal surface.
Bottom panel: Vertical velocity of the float $(-\partial P/\partial t)$ and vertical velocity past the float based on temperature change $[(\partial T/\partial t)/(\overline{\partial T/\partial P})]$ and rotation (ω) of the float. Data has been smoothed with a Butterworth filter having a half-power point at 10 min.

The COOL float must be moving from one water mass to another during its mission (Figures 3). The float mission can be divided into two parts. For the first half of the mission, the float is at a constant pressure with internal waves present but seeing a decrease in water temperature and rotating due to a vertical velocity past it (the positive w during this period). In the second half of the mission, the float is not seeing a temperature change or rotating; however, its pressure is increasing. As expected, the vertical velocity estimated from pressure $(-\partial P/\partial t)$ is dominated by internal waves. The high frequency oscillations in the vertical velocity based on temperature $[[(\partial T/\partial t)/(\overline{\partial T/\partial P})]$ is due to bit noise of the temperature data, even though the data has been smoothed over 10 minutes (Figure 3).

The analysis of all eight missions are presently underway. Comparisons of vertical velocities with XBT and CTD profiles (first six deployments) will be made

IMPACT/APPLICATIONS

The production of a COOL float will allow many investigators to study coastal ocean processes. The Graduate School of Oceanography has made their float technology available to the oceanographic community as evident through the commercially available RAFOS float.

REFERENCE

Hebert, D., M. Prater, J. Fontaine and T. Rossby. 1997: Results from the test deployments of the COastal Ocean Lagrangian (COOL) float, *Graduate School of Oceanography Technical Report* **97-2**, University of Rhode Island (in prep.)

Rajamony, J., S. Peterson, J. Fontaine, D. Hebert, T. Rossby and M. Prater. 1996: Vane Design for the COastal Ocean Lagrangian (COOL) Float, *Graduate School of Oceanography Technical Report* **96-8**, University of Rhode Island, 24pp.

Rossby, T., D. Dorson and J. Fontaine. 1986: The RAFOS system, *J. Atmos. Ocean. Techn.*, **10**, 609-617.

Rossby, T., J. Fontaine and E.C. Carter, Jr. 1994: The f/h float — measuring stretching vorticity directly, *Deep-Sea Res.*, **41**, 975-992.

Details of all eight deployments can be found at:
http://micmac.gso.uri.edu/hebert/cool_float